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3 Antennas

General Information

The antenna captures the video and audio signals that are broadcast from the satellite and converts it into a signal that the system receiver can use. It is the most important component of the WORLDNET Television Receive Only (TVRO) system. It may be installed on the roof of a building or on the ground. See Table 3.1, Antenna Specifications for information on antenna size requirements.

TABLE 3.1, ANTENNA SPECIFICATIONS

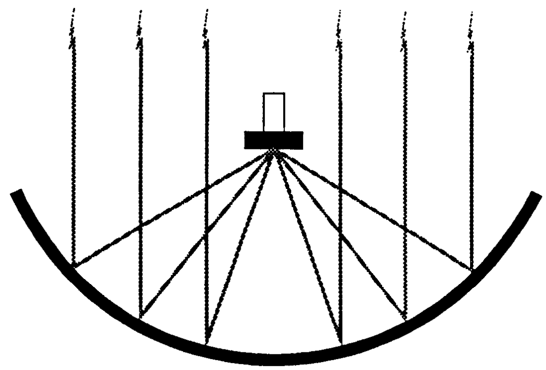
SIGNAL TYPE	ANTENNA DIAMETER SIZE
International	24 feet (7.5 meters)
Domestic - C-band systems	Smaller than 12 feet (3.6 meters)
Domestic - Ku-band systems	3.28 feet (1 meter)

Antenna Features

Focal Point

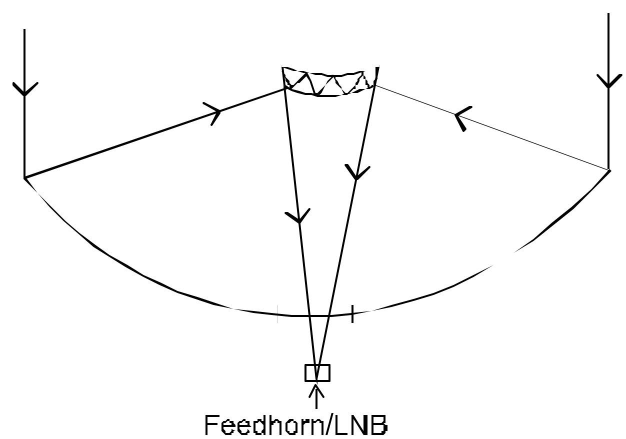
This is the point of the antenna at which all signal reflections from the antenna's surfaces meet. Most TVRO antennas focus signal to a point in front of the antenna called the *prime focus*, as shown in Figure 3.1.

Figure 3.1, Antenna Prime Focus Focal Point



Some newer antenna designs reflect the signal a second time back through an opening in the center of the main antenna. This focal point is called *Cassegrain focus*, and is shown in Figure 3.2.

Figure 3.2, Antenna Cassegrain Focal Point



Antenna Beamwidth

The greatest antenna sensitivity occurs in the direction the antenna is pointed, and diminishes rapidly away from the pointing direction. The angular width at which the antenna sensitivity falls to one-half of the maximum (-3 dB) is defined as the antenna beamwidth. At even greater angles, the antenna has some sensitivity (called sidelobes). Often unwanted signals (noise) are picked up through these sidelobes.

Antenna Gain

This is an antenna's ability to capture and amplify an incoming signal. Gain is measured in units of decibels (dB), referenced to an isotropic source (dBi). An isotropic source is a theoretical antenna model that receives signals equally well from all directions at once. This model is assigned a gain of 0 dB.

The gain of a parabolic antenna is directly related to:

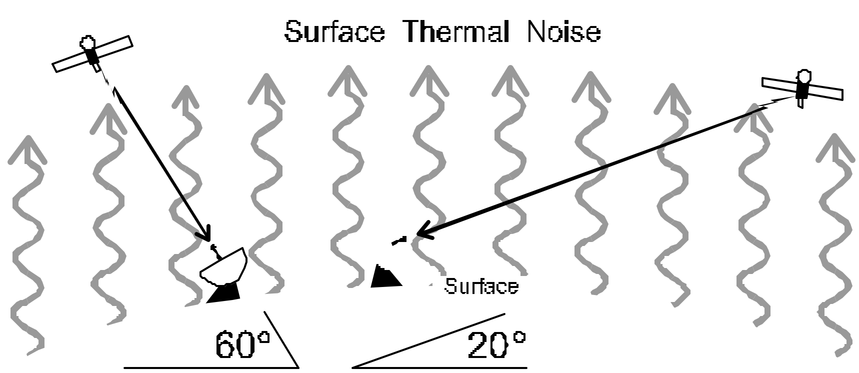
- The antenna's size;
- The frequency of the incoming signal; and
- The accuracy of the surface curvature.

Generally, the bigger the antenna the greater the gain. The rate of gain is directly proportional to the frequency of the incoming signal. Imperfections, such as dents in the reflector's surface, cause the reflected signal from those points to miss the focal point or take longer to reach the focal point. This causes the signal reflections from those points to be out of phase with the signal reflections made by other portions of the antenna. The result is a reduction in the overall gain of the antenna.

Antenna Noise

This is any signal that interferes with the desired signal. A major factor contributing to antenna noise is surface thermal noise. Surface thermal noise is radiated from free space and the earth's surface, and may be several times stronger than the satellite signal being sought. The physical location of the antenna in relation to the satellite sending the signal affects the amount of thermal noise detected along with the satellite signal. The lower the elevation angle of the antenna, the more thermal noise may enter the antenna's sensitive beamwidth. This is shown in Figure 3.3.

Figure 3.3, Antenna Noise



Antenna G/T

This is stated as "G over T" and is the ratio of antenna gain to antenna noise temperature. Measured as decibels/degree Kelvin (dB/K°), it is often referred to as the figure of merit or best measurement of a TVRO antenna system. In nonmathematical terms, it is the measure of the antenna's ability to capture an incoming signal without capturing unwanted noise.

Antenna Mounts

These are the main means of support for the parabolic reflector and are one of the most critical parts of any satellite antenna system. They must be rigid enough to maintain a precise position. Slight antenna movements of even a fraction of an inch can make the difference between excellent reception and no reception at all. The mounts must keep the antenna precisely pointed, even during bad weather conditions. Surface accuracy depends in part on the support that the mounts give to the antenna. Flexing can occur if the mount does not adequately distribute stress. There are three types of antenna mounts, as follows:

Fixed Mount

A fixed (stationary) mount is used by a TVRO system dedicated to tracking a single geostationary satellite. Its direction (azimuth) and elevation settings are set during installation of the system and cannot be changed. If the target satellite's orbit should change, the entire system has to be completely reinstalled.

Polar Mount

A polar mount is used by a TVRO system that accesses more than a single communications satellite. The antenna's mounting's axis is set parallel to the Earth's polar axis. Different satellites along the geostationary arc are accessed only by moving the antenna from left to right. This type of mount cannot be used by a TVRO system that accesses a geostationary satellite having an inclined orbit.

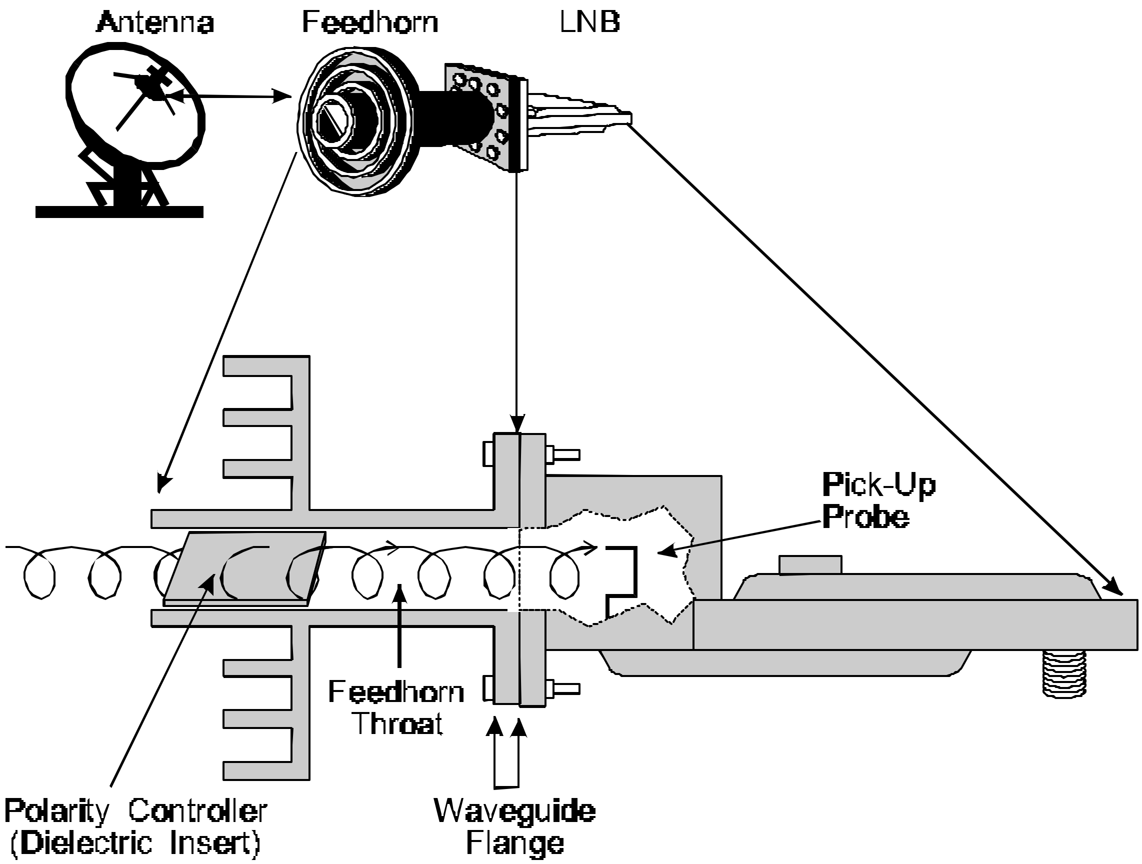
Az/El Mount

An azimuth/elevation (Az/El) mount is used by TVRO systems to access a geostationary satellite having an inclined orbit. Adjustments to both the azimuth and the elevation of the antenna can be made to track the satellite as its orbit changes.

Feedhorn

The feedhorn is located at the antenna's focal point and, although its shape and size may vary depending on the type of signal being received, its function remains unchanged. It collects the focused, concentrated signal and passes it on to the first stage of electronic amplification, the pick-up probe. The back end of the feedhorn is surrounded by the waveguide flange. This flange bolts directly to the flange surrounding the mouth of Low Noise Block Downconverter (LNB). This is shown in Figure 3.4.

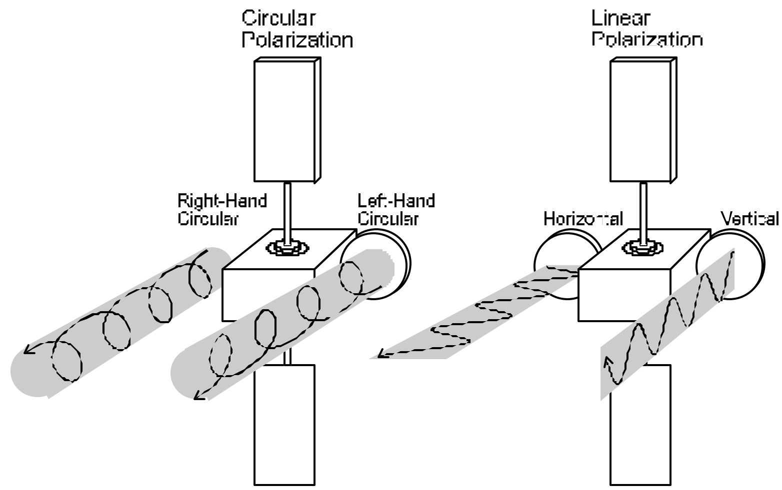
Figure 3.4, Antenna Feedhorn



Signal Polarization

This is the angle at which an electromagnetic wave signal is oscillating. TVRO satellite signal polarization can be either linear or circular. Most domestic satellite antennas use linear polarization, simultaneously transmitting signals in both the vertical and horizontal planes on the same frequency. Many international satellites, however, use a spiraling polarizing pattern called circular polarization. The electromagnetic field of the transmitted signal rotates in either a counterclockwise direction, called right-hand circular polarization (RHCP), or in a clockwise direction called left-hand circular polarization (LHCP). Figure 3.5 illustrates these types of satellite signal polarizations.

Figure 3.5, Signal Polarization



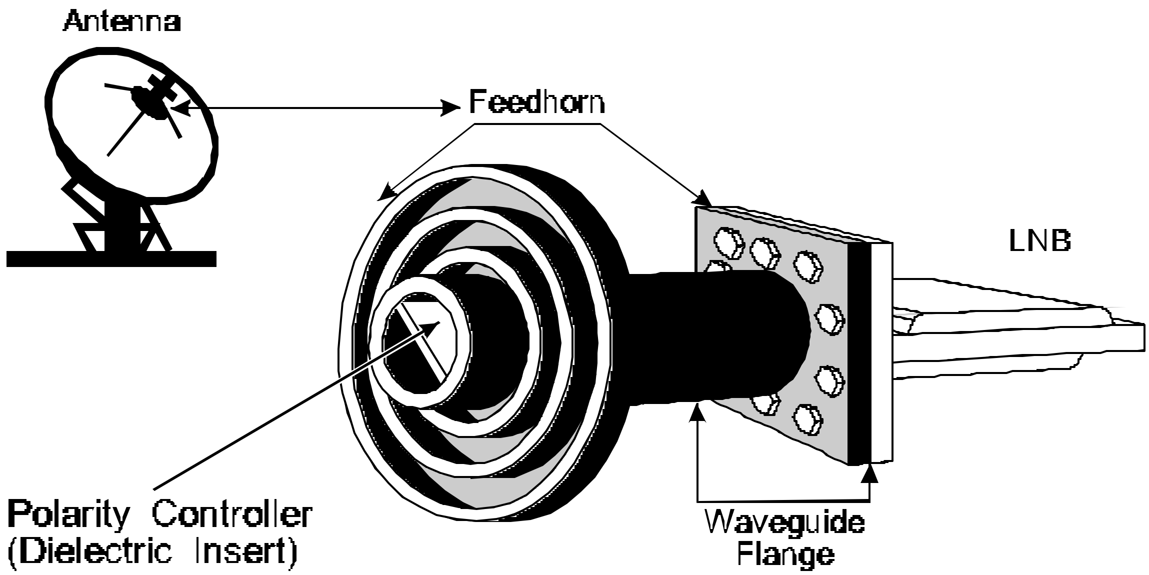
Frequency Reuse

This occurs when the same frequency is used with different signal polarizations to transmit different programs without interference occurring in the transmissions. For example, a football game and a news program may both be transmitted at the same frequency from a satellite with one being transmitted with horizontal polarization and the other with vertical polarization.

Polarity Controller

Also referred to as a dielectric insert, this directs a circularly polarized signal down the throat of the feedhorn to the pick-up probe. It is a Teflon disc or rectangle, lying perpendicular to the plane of the rotating signal. Figure 3.6 illustrates the positioning of a polarity controller within a feedhorn.

Figure 3.6, Polarity Controller



Low Noise Block Downconverter (LNB)

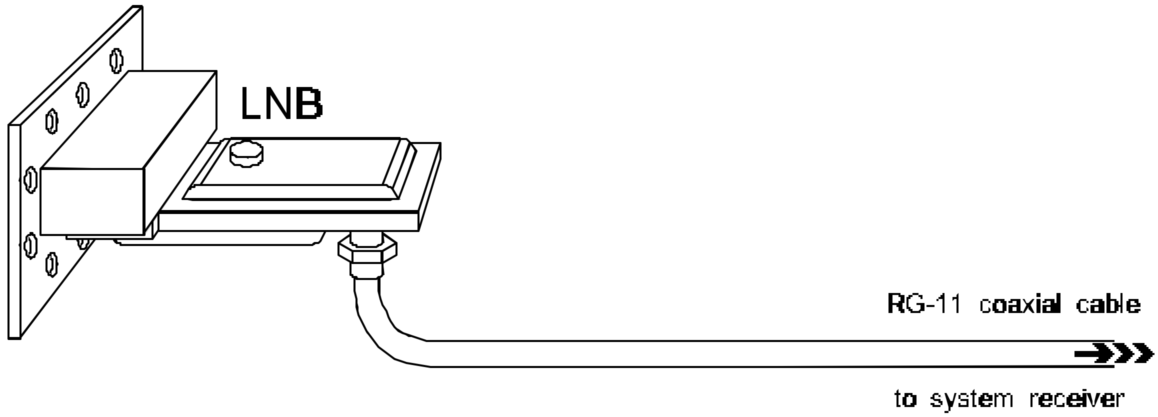
The LNB amplifies the incoming signal, reduces this signal to a lower frequency range, and passes it into the RG-11 coaxial cable running to the system receiver.

The electronics within the LNB begin with the pick-up probe located in the front cavity of the LNB housing (See Figure 3.4). TVRO systems within the WHA and Asia use a servomotor to change the position of the pick-up probe to match the polarization of the transmitted signal. The captured signal is passed to a transistor that amplifies signal frequencies in the range 3.7 to 4.2 GHz for C-Band transmissions, or in the range 10.95 to 12.75 for Ku-Band transmissions.

It is very important that the signal is amplified without introducing any electronic noise into the signal. Any noise introduced during amplification will affect all later stages of amplification and processing. Realistically, perfect signal amplification, or amplification without the introduction of noise, does not exist, but the electronic temperature within the LNB is reduced to 20 to 25 Degrees Kelvin to minimize the noise. Each LNB is selected for a specific low-noise temperature rating based on the frequency of the transmitted signal(s) being received.

A built-in block downconverter (BDC) then reduces the signal's frequency to a range of 950 to 1750 MHz by mixing the incoming frequency with a lower, stable frequency generated by an oscillator within the BDC. This frequency reduction provides a signal that can be used by the system receiver and minimizes signal loss within the RG-11 coaxial cable from the LNB to the system receiver. Figure 3.7 shows these connections.

Figure 3.7, Low Noise Block Downconverter (LNB)



IRTE Antenna

IRTE antennas of 1.8 to 2.4 meters in diameter are manufactured by a major Italian antenna manufacturer. The antenna locates the feedhorn and LNB at the prime focus. Both polar and azimuth/elevation mounts are available. The antennas are used by TVRO sites in Europe to receive Ku-band signals from the medium-gain beam transmitted from the EUTELSAT satellite.

Technical Specifications

Manufacturer		IRTE International Ltd. Charter House, Queens Avenue London N21 3JE- United Kingdom 44-1-3601925 Fax 895951147003001
1.8 Meter	Frequency, GHz Gain, dBi	10.9 11.3 11.7 44.0 44.3 44.6
	Noise temperature ($^{\circ}$K) at 25° look angle	34°
	F/D ratio	0.41
	Max. azimuth adjustment	360°
	Max. zenith tilt	> 70°
2.4 Meter	Frequency Gain	12.25 12.50 12.75 47.4 47.5 47.6
	Noise temperature ($^{\circ}$K) at 25° look angle	45°
	Max. azimuth adjustment	360°
	Max. zenith tilt	0° / 70°

Paraclipse Antenna

Paraclipse 4.8 meter antennas are used by TVRO sites in Europe, Africa, and the Western Hemisphere Affairs (WHA) regions to receive C-band signals from high-power hemispherical beams transmitted from the Atlantic Ocean region's (AOR) INTELSAT satellite. Paraclipse 4.8 meter antennas are also used in the Caribbean and Mexico to receive the C-band signal transmitted from the GE-2 satellite.

Technical Specifications

Manufacturer	Paraclipse Inc. 2271 29th Avenue East Columbus, NE 68601 (402) 563-3625 Fax (402) 564-2109
Model, Size	Classic, 4.8 Meters
Gain, dB	44.8
Beamwidth (-3 dB)	0.9 deg
Aperture Efficiency	65 %
C-Band Antenna Noise Temperature	21 °K @ 45 deg elevation
First Side Lobes at **Down**	1.9 deg -20.0 dB
F/D ratio	0.3
Focal point	1.429 m (57 inches)
Antenna Mount	Polar

Telesat Antennas

The Telesat International, Ltd. 7.5 meter antennas are used at TVRO sites in the Middle East, Indian Ocean region, and in Eastern Asia, using the Indian Ocean Region (IOR) INTELSAT and AsiaSat2 satellites.

These antennas operate in the C-Band at 3.7 – 4.2 GHz, and are mounted on motor-driven AZ/EL mounting pedestals. Feedhorn and LNB are located at the prime focus.

Technical Specifications:

Manufacturer	Telesat International, Ltd. 20122 S. Molalla Ave. Oregon City, OR 97045 (503) 656-2774; FAX: (503) 657-9945
Model, Size	7.5 meter
Minimum Gain (@ 4GHz)	48.0 dBi
Beamwidth (@ 4GHz)	±0.34° (@ -3 dB)
Maximum Depth	1.281 meters
Feed Arrangement	Prime Focus
F/D ratio	0.36585
Focal Distance	2.743 meters / 108 inches
Subtended Angle at Focus	135.5°
Noise temperature (°K) (at 30° elevation angle)	Approx. 21°
Antenna Mount Type	AZ/EL
Azimuth Range	180°
Elevation Range	0° to 90°
Material, Reflector Surface	Aluminum Mesh
Material, Mount	Galvanized Steel

Vertex Antennas

The Vertex Communications Corporation 6.1 meter antennas are used at the TVRO site in Tokyo only.

These antennas are compact Cassegrain designs with the feedhorn and LNB located behind and in the center of the main reflector. The pointing system is Az/El with motor-driven actuators. Signal polarization is chosen by a servo-driven motor.

Technical Specifications:

Manufacturer	Vertex Communications Corporation 2600 Longview St. P.O. Box 1277 Kilgore, TX 75663
Model, Size	6.1 meter KPC (Kingpost Pedestal)
Antenna Type	Compact Cassegrain
Frequency, Band	3.625 – 4.200 GHz, C-Band
Antenna Gain (@ 3.912 GHz)	46.4 dB
Antenna Noise Temperature (@ 20° Elevation)	35°K
Typical G/T (@ 20° Elevation, 40°K LNB)	27.3 dB/K
Pattern Beamwidth	0.82° (@ -3 dB)
First Sidelobe	- 14 dB
Azimuth Range	180°
Elevation Range	0° to 90° continuous
Polarization Range	±90°
Finish, Panels	Aluminum Panels with heat-diffusing white paint
Finish, Pedestal	Red oxide primer and two coats of enamel

Other Antennas

ADM Antenna

ADM 5 Meter antennas are used in the Western Hemisphere Affairs (WHA) to receive C-band signals from the high-power hemispherical signal beam transmitted from the Atlantic ocean region (AOR) INTELSAT satellite.

Inter-Continental Antenna

Inter-Continental antennas of 6.0 to 7.5 Meters in diameter, are used by TVRO sites in east Asia and near east Asia and to receive C-band signals from the low-power hemispherical and global signal beams transmitted from the AsiaSat2 and Indian Ocean region (IOR) INTELSAT satellites.